Appendix F

TENNESSEE VALLEY AUTHORITY

Office of Natural Resources and Economic Development

LOCAL DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

May 1988

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Office of Natural Resources and Economic Development

LOCAL DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

Prepared by the

Division of Air and Water Resources

With Assistance From the

Tennessee Office of Water Management

and

Norris Water Commission

May 1988

ACKNOWLEDGMENTS

This plan was prepared by Stanley J. Wentz of the Tennessee Valley Authority (TVA), Office of Natural Resources and Economic Development, Division of Air and Water Resources, Flood Protection Branch, through TVA's Regional Water Management Program with assistance from the Tennessee Office of Water Management (TOWM) and Norris Water Commission (NWC). Special appreciation is extended to TVA's Engineering Laboratory (James W. Ferrell, Sr., and J. B. Perry), TOWM's Knoxville Regional Office (Debbie Hines), and NWC's Superintendent (Benny Carden) for their cooperation and assistance in providing the basic information and data used in developing the plan. Also, a special thank you to the following entities who assisted in the editing and review of the plan: TOWM (James W. Haynes, Lee Keck, and Jack Tompkins) and TVA (Larry R. Clark and James H. French).

EMERGENCY OPERATIONS PROCEDURE FOR DROUGHT MANAGEMENT

This procedure was developed through a joint, cooperative effort involving the Tennessee Valley Authority, Tennessee Office of Water Management, and Norris Water Commission. Essentially, it outlines a plan of action to be followed by the Commission and system personnel in dealing with drought-related water supply shortages. Summarized below is a list of the basic steps or actions to be followed by the Norris Water Commission to monitor the system's potential for drought-related water supply shortages and negate or minimize the adverse effects of these shortages.

1. Assess and monitor the system's water supply/use relationship on a continuing basis including such factors as precipitation, temperature, reservoir and groundwater levels, daily and peak water use, etc.

2. Identify the conditions such as precipitation, reservoir and groundwater levels, temperature, etc., which would signify the existence of drought-like conditions and potential for drought-related water supply shortages in the area served by the system.

3. Analyze the system's infrastructure condition and determine its adequacy to meet existing and near-term water demands in light of existing and possible water supply/use conditions. This should be done from the standpoint of both quantity and quality.

4. Establish the appropriate mechanisms (public information/education, enforcement powers, ordinances, etc.) to (a) increase the public's awareness of Norris' water supply situation and the potential for drought and (b) facilitate implementation of the needed actions when supply shortages do occur, in a timely and orderly manner, with the public's full cooperation and support.

5. Identify and analyze alternative sources of supply and select one or more supply alternatives which could most readily be utilized by the system during a drought period. To the extent possible, the system should do everything it can in advance of any shortages to facilitate the utilization of those alternative sources of supply as quickly and efficiently as possible.

6. Implement, when appropriate, the actions specified below under each drought stage delineated in Norris' local drought management plan to reduce water use.

   - "Conservation Phase". This phase, requiring a 15 to 20 percent reduction in water use, would be implemented when the annual precipitation at Norris' water treatment plant dropped below 50 percent of normal for an average year or the overflow from Clear Creek Spring ceased entirely. Under the "conservation" phase, the Norris Water Commission would:

     a. Encourage homeowners to install water-saving devices and repair household leaks.

b. Reduce water sales to the Andersonville Utility District from 153,000 GPD (1987 average daily purchase) to 130,000 GPD.

c. Request all of its customers to conserve water voluntarily.

- "Restrictions" Phase. Assuming an average flow of 380 gallons per minute (GPM) for Clear Creek Spring, this phase, requiring a 30 to 40 percent reduction in water use, would be implemented when spring flows decreased to 235 GPM. Under the "restrictions" phase, the Commission would:

  a. Require mandatory water conservation for all nonessential and "second and third class" essential water uses.

  b. Reduce water sales to the Andersonville Utility District from about 153,000 GPD (1987 average daily purchase) to 100,000 GPD.

  c. Install pressure-reducing devices in the system's main lines and enforce the levying of fines or penalties for excessive water use.

- "Emergency" Phase. This phase, requiring a 60 percent or greater reduction in water use, would be implemented when spring flows fall to 150 GPM or less. Under the "emergency" phase, the Commission would:

  a. Expand mandatory water conservation to include all "first class" essential water uses and continue enforcement measures to reduce water use.

  b. Reduce water sales to the Andersonville Utility District from about 153,000 GPD (1987 average daily purchase) to 75,000 GPD.

  c. Install an emergency water intake in the Clinch River at mile 78.11 to supplement the available supply from Clear Creek Spring.

LOCAL DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

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INTRODUCTION

During the summer of 1986, the town of Norris experienced serious water supply concerns due to a decrease in flow from Clear Creek Spring, its only source of supply, from an estimated average flow of 380 to 230 gallons per minute (GPM). This flow was one of the spring's lowest since the 1953-1954 drought. Although serious water supply shortages were averted, the Norris Water Commission did find it necessary to (1) reduce the amount of water sold to the Andersonville Utility District and (2) issue notices to all of its customers requesting their voluntary cooperation in the conservation of available water supplies by not watering lawns or washing cars.

In view of the continuing drought-like conditions, which extend back to the summer of 1984, the Commission, with assistance from the Tennessee Office of Water Management and the Tennessee Valley Authority, has developed a local drought management plan for Norris' public water supply system. This plan was developed in accordance with the general guidance and direction provided in Tennessee's Interim State Drought Management Plan published in January 1987 and the Local Drought Management Planning Guide for Public Water Suppliers published in 1988 by the Tennessee Department of Health and Environment, Office of Water Management. More specifically, the development of drought management plans for local communities is mandated in Tennessee's Safe Drinking Water Act, Tennessee Code Annotated (T.C.A.), Section 68-13-710; Water Quality Control Act, T.C.A., Section 69-3-109(b); Civilian Defense Act, T.C.A., Sections 58-2-101 through 58-2-518; and Executive Order No. 4 (Keck, January 1987).

PLAN PURPOSE AND GOALS

The purpose of this plan is to delineate a course of action to be followed by the Norris Water Commission and system superintendent in dealing with drought-related water supply shortages to limit the adverse effects of drought on the system's customers. More specifically, the plan will help system personnel to:

1. Assess the system's situation relative to the source capacity of its source of supply, hydraulic limitations of the system, average daily and peak water use by type of customer, potential water quality problems, and alternative sources of supply.

2. Delineate a procedure, including the identification of key "trigger" points or conditions, for monitoring local water use/supply relationships in the Norris public water supply system during drought periods.

3. Identify specific drought stages, i.e., percent reductions in available water supplies, at which certain actions will be taken.

4. Implement specific actions and measures at the appropriate time(s) to facilitate the system's timely and orderly resolution of drought-related water supply shortages.

The basic goals of this plan are to:

1. Provide for the equitable and fair distribution of water during drought conditions to minimize adverse economic, environmental, social, and health-related impacts and ensure that local circumstances are recognized and critical needs are met.

2. Establish a viable basis for the implementation of pertinent drought-related water supply management decisions.

3. Delineate specific actions and measures that will be taken to alleviate drought-related water supply shortages.

OVERVIEW OF PLAN ELEMENTS

This portion of the plan describes briefly the basic information and/or data contained in each of the plan's basic elements or sections.

1. Introduction. A brief description of the basic rationale for and authority under which Norris' local drought management plan was developed.

2. Plan Purpose and Goals. A brief statement describing the plan's overall purpose and its basic goals and objectives.

3. Overview of Plan Elements. An overview and description of the basic information and data contained in each section or plan element.

4. Agency Roles and Responsibilities in Plan Development and Implementation. This section delineates the roles and responsibilities of local, state, regional, and Federal agencies in dealing with drought-related water supply shortages.

5. Public Education and Involvement in Plan Maintenance and Implementation. This section of the plan describes the basic elements of an effective public education program and identifies alternative methods for use by Norris in educating and sharing drought-related information with the public.

6. Description of the Norris Public Water Supply System. A thorough description of Norris' public water supply system infrastructure, its source of supply and average daily and peak water use, and the quality of existing water supplies.

7. System to Monitor Available Water Supplies and Determine the Potential for Drought-Like Conditions to Occur. This portion of the plan describes the system and key environmental factors or conditions to be used by Norris in monitoring and evaluating the quantity and quality of existing water supplies to facilitate the declaration of a drought alert and potential water supply shortages during drought periods.

8. Phased Responses to Reductions in Supply. A description of the specific phases or levels of service, i.e., varying degrees of water supply shortages, at which selected program actions and measures are implemented to deal with supply shortages.

9. Water Use Priorities. This section of the plan establishes local priorities for water use by classifying local users into four basic groups: essential (first, second, and third class) and nonessential uses.

10. Identification and Evaluation of Alternative Sources of Supply. This part of the plan describes and evaluates the pros and cons of a number of water supply alternatives which the town of Norris could consider utilizing to alleviate water supply shortages.

11. Selected Drought Management Plan for Norris, Tennessee. This portion of the plan identifies a set of specific program actions that will be implemented by the town of Norris to deal effectively with local water supply shortages.

12. Plan Implementation Ordinance No. 359. This section of the plan contains a proposed ordinance which passed the first of three readings by the Norris Water Commission on May 9, 1988. This ordinance authorizes the Commission to implement specific program actions to resolve or mitigate water supply shortages.

13. Plan Enforcement. This part of the plan describes the procedure that will be used by the Norris public water supply system to enforce the implementation of specific program actions.

14. Plan Update and Revision. This portion of the plan indicates the need for periodic plan revision and update to reflect changes in existing water use/supply conditions.

15. Plan Recommendations. Summary compilation of the plan recommendations contained in the preceding sections of the plan.

16. Plan Glossary. This part of the plan contains the definition of key terms which are utilized in the plan.

17. Selected References List. This section includes a bibliographic listing for all reference and resource materials which were used in the preparation of Norris' local drought management plan.

AGENCY ROLES AND RESPONSIBILITIES IN PLAN DEVELOPMENT AND IMPLEMENTATION

Generally, water supply shortages can be addressed and resolved most effectively at the local and/or regional level of government. However, state and Federal agencies also have an important role to play in providing for the effective use of a community's available public water supplies, particularly during periods of severe and extended drought

conditions. While specific agency roles and responsibilities relative to the development and implementation of Norris' local drought management plan, particularly the local role, are indicated in the various plan elements, a broad general overview of each governmental entity's role in drought management is presented below. (Keck, January 1987)

Local/Regional Role

The basic roles and responsibilities of local communities, such as the town of Norris, include the following:

1. Develop water shortage or drought management plans which address and are responsive to local problems and circumstances.

2. Evaluate the adequacy and ability of the system's existing infrastructure (distribution system and treatment and storage facilities) to meet existing and future needs and, if necessary, upgrade and/or expand existing infrastructure facilities or develop additional facilities to meet needs.

3. Monitor existing water supply sources and daily water use for specific purposes and anticipate user demands.

4. Identify and monitor potential water use problems and conflicts.

5. Identify and evaluate the pros and cons of a wide variety of alternatives, including other sources of supply, which the community could utilize to deal with potential water supply shortages.

6. Establish specific phases (conservation, restrictions, and emergency) reflecting different levels of water supply shortages at which pertinent program actions would be implemented to deal with the shortages.

7. Establish an effective mechanism for (a) educating and informing the public about drought and local water supply shortages and (b) acquiring public participation in and input to the local drought management planning and implementation process.

8. Adopt standby rates and pertinent ordinances and codes.

9. Establish mutual aid agreements, interconnections with other systems, and conservation education programs.

10. Notify the Tennessee Office of Water Management (TOWM) of all source conflicts and problems encountered in the implementation of local drought management plans.

State Role

Basically, the State's role in resolving and dealing with drought-related problems is to provide water management information, technical assistance, and regulatory oversight. More specifically, these duties would include the following activities.

1. In accordance with its delegated authority and legislative mandates, TOWM will serve as the State's focal point for the dissemination of hydrologic data.

2. When appropriate, TOWM may issue a local, regional, or statewide "drought alert" to alert users and suppliers of the (a) need to evaluate hydraulic or source stress and (b) possible need to reduce water demands through conservation.

3. During a "drought alert," TOWM would maintain weekly contact, through its regional field offices, with those water supply systems and industries considered to be "drought sensitive" or as "having a potential for a shortage."

4. Under Tennessee's "Interim State Drought Management Plan" issued in January 1987, TOWM's Division of Water Supply will solicit and review public water supply systems drought management plans.

5. The State will also work with the Tennessee Valley Authority (TVA) and U.S. Army Corps of Engineers (COE) to modify established reservoir operations and procedures, wherever possible within the existing statutory limitations, to provide the streamflows deemed necessary to maintain water quality and economic viability as well as serve other purposes.

6. In the event of an emergency water supply shortage situation, TOWM has the authority, either independently or through a concurring declaration of emergency by the Governor, the Tennessee Emergency Management Agency, and the Tennessee Department of Health and Environment, to mediate or resolve water use conflicts between competing users including protection of the environment.

Federal Role

The role of the Federal agencies during a drought will depend on the specific water-related resources under their management. Federal agencies having major water-related responsibilities in Tennessee including TVA, COE, U.S. Geological Survey, Environmental Protection Agency, Fish and Wildlife Service, and Soil Conservation Service. More specifically, these agencies responsibilities include the following:

1. Cooperate with the State of Tennessee by providing pertinent information and data relative to water quality conditions, reservoir and groundwater levels, and changes in reservoir management.

2. Cooperate with one another to protect critical habitat areas and maintain normal operations and programs.

3. Inform recreational users of reservoir hazards due to poor water quality or low water levels.

In addition, all Tennessee military units will provide, to the extent possible, needed water treatment and water hauling equipment when requested.

PUBLIC EDUCATION AND INVOLVEMENT IN PLAN MAINTENANCE AND IMPLEMENTATION

Public education will be the key to the success of Norris' plan for dealing with drought-related water supply shortages. In general, the public education program should be an ongoing, two-pronged effort: public education and information transfer.

1. Public Education. To inform and educate the general public about the area's water resources, existing water use/supply relationships, potential for water supply shortages to occur during prolonged periods of drought, and importance and means of conserving water.

2. Information Transfer. To distribute basic water supply-related information and data to the public. Under normal rainfall conditions, the program should provide the public with general information regarding the Norris water supply system's infrastructure (treatment plant and distribution system) and source of supply, potential for experiencing water supply shortages, and importance of water conservation. During periods of below-normal rainfall and/or other extenuating circumstances, the program should provide information describing existing water use/supply relationships, the nature and extent of existing or potential water supply shortages, and specific methods for conserving existing water supplies and reducing water use. The public should also be notified of any changes in the source of the system's water supply, unique quantity- and/or quality-related problems, and decisions to penalize those not following established conservation measures during a time of drought.

To ensure public credibility and cooperation in plan implementation, all information and data provided should be clear and concise, as accurate and current as possible, and specific about what action or response is desired from the public.

Public education and information transfer can best be accomplished through the use of a variety of methods including the following:

1. Presentations to schools, civic groups and service organizations, businesses, church groups, scout troops, etc.

2. Newspaper articles and public service announcements.

3. Development of video tapes or slide shows for use in public presentations.

4. Preparation and distribution of pamphlets, brochures, and posters promoting conservation to all water users.

5. Distribution of water conservation bumper stickers, buttons, and decals.

6. Public demonstrations and displays at shopping centers, schools, fairs, etc.

7. Enclosure of water bill inserts such as memorandums, brochures, etc.

8. Free distribution of inexpensive flow restriction devices.

While there are numerous methods which can be used to provide pertinent water supply related information and data to the public, the Norris Water Commission has successfully used memorandums to convey pertinent information to its customers. For example, in July 1986, the Commission issued a memorandum to all of its customers requesting voluntary restrictions on water use for all unnecessary water uses. Appendix I contains a copy of the Commission's July 1986 memorandum and several sample press releases which could be used by the Commission to inform the public of impending water supply shortages and the need to conserve water.

Analysis of the Commission's current public education program indicates that, to date, its primary function has been to request the Commission's customers to reduce their water use by temporarily eliminating unnecessary water uses such as lawn watering and car washing during dry periods. In light of the decrease in Clear Creek Spring's average flow from 380 to 230 GPM during the summer of 1986 and the continuing drought, it is recommended that the Commission give consideration to establishing and undertaking a program designed to inform and educate the public about the area's water resources, the potential for water supply shortages, and the importance of water conservation. Specific methods to be utilized in accomplishing these goals would be up to the discretion of the Commission and could be selected from the preceding list.

DESCRIPTION OF THE NORRIS PUBLIC WATER SUPPLY SYSTEM

This portion of the plan describes Norris' public water supply system infrastructure and operations organization, source of supply, average daily and peak water use, and water quality.

Basic Operations Organization and Infrastructure

Overall responsibility for overseeing the operation of the Norris Water and Wastewater System for Norris, Tennessee, belongs to the Norris Water Commission. The Commission consists of three members who are appointed by the Norris City Council for 6-year terms at staggered 2-year intervals. Day-to-day operation of the Norris Water and Wastewater System is conducted by the system superintendent and three employees who are responsible for the operation and maintenance of one water and two wastewater treatment plants, including the water distribution, metering, and sewer collection facilities. The water system is totally metered and excellently maintained and operated with very good records. All water processed by the system is approved by the Tennessee Department of Health and Environment (TDHE) based on inspections of the system's operation and maintenance during routine sanitary surveys with the system consistently rating in the high 90s out of a possible 100. The quality of the system's maintenance is also evidenced by the fact that (1) total water losses have decreased from 35 to 13 percent in recent years and (2) the system's average monthly, unaccounted-for water loss is only about

8 percent--one of the lowest in the State. The system has an ongoing leak detection and valve, fire hydrant, and meter change-out program. Billing for water and sewer charges is done by the town of Norris.

This system's water supply infrastructure consists of four basic parts: spring box and pump station, water treatment plant, storage system, and distribution system. Each of these components is described below. In addition, information is provided, where available, relative to any water supply problems experienced by the system's customers in recent years due to physical or infrastructure limitations.

1. Spring Box and Pump Station. These facilities are located at Clear Creek Spring about 3,000 feet from the system's water treatment plant. The spring box and pump station were built in 1933 as part of the Tennessee Valley Authority's (TVA) construction of Norris Dam and are in good condition. The pump station consists of five electrically operated pumps--three 150 GPM and two 350 GPM high service pumps--and one gasoline-powered 200 GPM stand-by pump for use if the electrically operated high service pumps fail. Normally, the pump station operates about 12 hours per day and up to 18 hours per day during periods of peak demand. Operation of the pump station for extended time periods to meet peak system demands causes accelerated wear on the pump station facilities resulting in their being more likely to break down.

   Several attempts have been made to measure the spring's flow capacity by capturing the spring's overflow in the spring box and using a weir to monitor the flow. However, to date, it has not been possible to keep all of the flow in the spring box.

2. Water Treatment Plant. This system's treatment plant was constructed in 1967 and has a design capacity of 432,000 gallons per day (GPD). By using the system's 350 GPM high service pumps, the plant's capacity can be increased to 520,000 GPD. The plant is equipped with pressure filters and pre- and post-chlorination, fluoridation, coagulation, and pH-adjustment facilities.

   During operation, water flows from Clear Creek Spring to the system's filter plant by gravity through an 8-inch pipe. At the filter plant, the water is pumped by three 150 GPM pumps through sand filters and is chemically treated by automatic systems. Chlorine is added for disinfection. Fluoride is added for dental health. Alum is introduced for turbidity removal and soda ash is introduced for pH-adjustment.

   While the system's treatment plant is in excellent condition, the fact that the treatment plant's maximum capacity of 520,000 GPD is being rapidly approached by the system's peak daily use of 519,000 GPD is an area of concern for the system. Although the system's average daily use is only about 75 percent of the system's designed treatment plant capacity, it should be noted that systems whose average daily water use exceeds 80 percent of the designed treatment

plant capacity are likely to experience difficulties in meeting water demands if water use increases. Therefore, based on the relationship between the system's maximum treatment capacity and peak daily use as well as the limited cushion between average daily use and the system's designed treatment plant capacity, it is recommended that the Norris Water Commission should evaluate the potential for increases in both the average daily and peak water use and begin to plan for and implement, as appropriate, the expansion of the system's treatment plant capacity.

Any decision to increase the treatment capacity of Norris' water supply treatment plant should be closely coordinated with the system's analysis, identification, and development, if necessary, of additional or alternative water supply sources. This is particularly important because alternative sources of supply may require treatment which is beyond the capability of Norris' present treatment system. Thus, if the decision is made to expand the system's treatment plant capacity, it should also consider and provide, as appropriate, for making those system modifications needed to facilitate the plant's providing adequate treatment for any additional or alternative sources of supply (Clinch River, Norris Reservoir, etc.) which could be utilized by the system at some point in the future.

3. Storage System. Total storage for treated water equals 430,000 gallons. This includes one 100,000-gallon clearwell; one 250,000-gallon reinforced-concrete, underground reservoir; and 80,000 gallons of storage in the system's distribution lines and mains. The clearwell was constructed in 1967 and is located beside the treatment plant on Clear Creek. The underground reservoir is located on Reservoir Hill and was constructed in 1933 during TVA's construction of Norris Dam. This reservoir is in good condition and its overflow elevation is 1369.5 feet above mean sea level.

   Following treatment, the treated water is pumped from the treatment plant into the clearwell and from there into the underground reservoir. Present system storage of 350,000 gallons in the clearwell and underground reservoir complies with the TDHE's minimum standards, which call for systems to have sufficient treated water storage for one day's average daily use. At the present time, the system's average daily use amounts to about 320,000 gallons with peak daily use amounting to about 520,000 gallons. Currently, the Norris Water Commission is planning to construct a new 500,000-gallon steel reservoir by the year 1990 or shortly thereafter to reduce the risk of drought-related water supply shortages and accommodate anticipated system growth and expansion.

4. Distribution System. Norris' distribution system consists of an estimated 25 miles of pipeline with 650 meters and three major purchasers. Approximately 19 miles of pipeline in the system consists of cast-iron, cement-lined pipe of 6-, 8-, and 10-inch sizes. This pipe was installed in 1933 during construction of TVA's Norris Dam facilities. The remaining 6 miles of the distribution system consist of 6-inch ductile iron, 2- and 6-inch polyvinylchloride (PVC),

4- and 6-inch asbestos cement, and 2-inch galvanized steel. Most of the distribution system is in excellent condition with only one and one-fourth miles of galvanized steel pipe in bad condition. This bad pipe will probably be replaced with 6-inch PVC tubing by 1992. Two percent of all service lines are made of PVC tubing and galvanized steel, while the remainder of the lines are made of "type K" copper tubing. It should be noted that the TDHE no longer approves the use of galvanized steel pipelines due to complaints of rusty and "red" water problems associated with the use of such pipelines. Therefore, it is recommended that the Commission give consideration to replacing all service lines made of galvanized steel by PVC or "type K" copper tubing, as time and finances permit.

Water is fed by gravity from the underground reservoir at elevation 1359 feet throughout the distribution system in and around Norris. While problems are very limited, there are a few areas in Norris where the supply lines are too small to carry enough water for several customers to water lawns and gardens at the same time. When several customers on the same supply line are using large amounts of water at the same time, other customers on the same line may experience very low water pressure. Specifically, this problem has occurred several times along a portion of Reservoir Road east of Dairypond Road. To alleviate this problem of low water pressure, the town of Norris has established and implemented a program to replace, as funding and time permit, the small pipelines in the low pressure areas with larger lines. At present, Norris has less than 1,000 feet of small-sized pipeline which remains to be replaced.

Figure 1 is a topographic map of the Norris area depicting the relative location of key system facilities.

Source of Supply

Currently, the town of Norris gets all of its water from Clear Creek Spring which is located near the contact of the Chepultepec dolomite with the younger Longview dolomite of the Knox Group at elevation 925.3 feet (DeBuchananne and Richardson, 1956). Geologically, this area is karstic in nature with both of these formations being composed predominately of siliceous dolomite. Dolomite ($MgCO_3$) is not as subject to solution weathering as limestone ($CaCO_3$). Neither of these formations is, therefore, subject to extensive sinkhole development, except where beds of limestone may be present.

This spring is located in a forested area and is protected by both the town and the Norris Water Commission. Presently, Norris owns approximately 2,500 acres (about 4 square miles) of watershed area around the spring.

The actual flow capacity of this spring is unknown due to the loss of most of the spring's "early day" flow records in a fire some years ago. While it is difficult to obtain a direct measurement of the spring's flow because of its physical characteristics, i.e., the multiplicity of springs involved, a good estimate of Clear Creek Spring's flow could be

obtained by determining the amount of water pumped from Clear Creek and adding to it an estimate of the creek's remaining flow. During wet seasons, the spring's peak flow is estimated to be about 700 GPM or 1,000,000 GPD. On the other hand, during the drought of 1953-54, summer 1986, and fall 1987, spring flow decreased to 230 GPM or about 330,000 GPD. This flow (230 GPM) equals the spring's 100-year minimum flow determined by the U.S. Geological Survey during the 1953-54 drought.

While the recharge area for Clear Creek Spring is generally assumed to be located almost entirely within the town of Norris, this has never been substantiated by detailed hydrogeologic studies. This area is heavily wooded, except for a narrow strip of development along the area's southern boundary. Since Norris owns a part of this area (2,500 acres) and controls the remainder through a lease agreement with TVA, it is not anticipated that this area will be extensively developed within the foreseeable future. Appendix II contains a copy of the lease agreement between the town of Norris and TVA.

Since the extent and precise location of Clear Creek Spring's recharge area is unknown, the potential for contamination of this spring cannot be clearly ascertained. While the spring's relative chemical stability does indicate that the spring is not as susceptible to contamination as other karst springs, the spring's variable turbidity, although not excessive, does indicate some potential for possible surface contamination. Therefore, it is recommended that the town of Norris undertake a program designed to (1) more accurately delineate Clear Creek Spring's recharge area through the conduct of groundwater tracer experiments and collection of pertinent hydrogeologic data, (2) identify and analyze the basic land uses occurring within the spring's defined recharge area, and (3) monitor the impacts, if any, of these land uses on the spring's water quality. Once the spring's recharge area has been accurately delineated and relative susceptibility to pollution determined, the Norris Water Commission should proceed to (1) identify and implement, as appropriate and feasible, those measures which would minimize, to the extent possible, the pollution potential from existing land uses in the recharge area to those land uses which would not adversely impact the spring.

In the event that Norris' present source of supply were to become inadequate due to periods of deep, continuing drought and/or increased system use through growth, the system would consider withdrawing water from either the Clinch River below Norris Dam at river mile 78.11 or Norris Reservoir. These points of withdrawal are located about 5,800 and 7,600 feet respectively from the system's water treatment plant. The quality of the water from both sources is good and would be compatible with the system's existing treatment facilities, thus posing no treatment problems for the town. To date, no facilities (pipelines, etc.) have been put in place to utilize water from either of these sources.

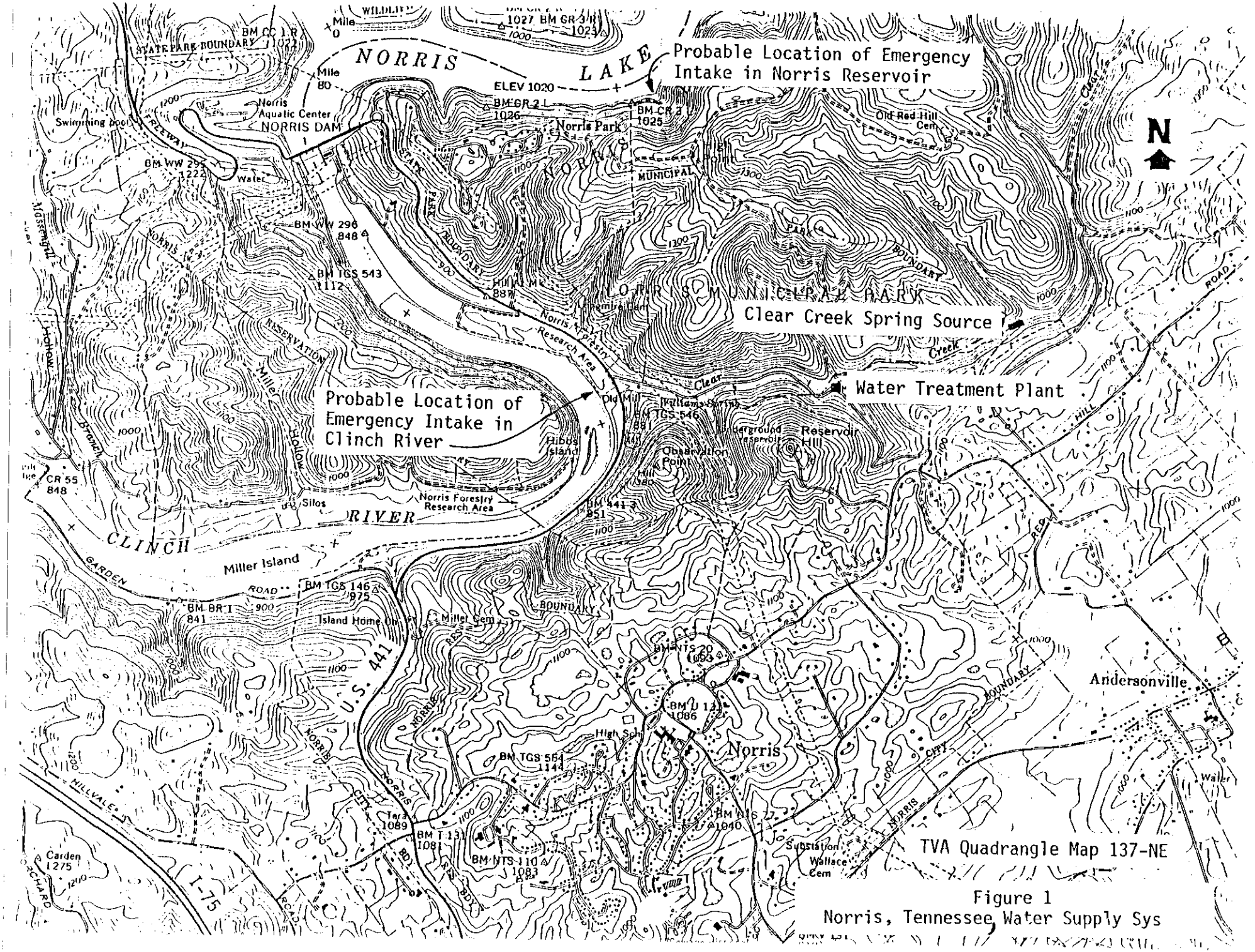

Figure 1
Norris, Tennessee, Water Supply Sys

Average Daily and Peak Water Use

Average daily water use, i.e., water pumped by the Norris public water supply system, during the period from January 1986 to July 1987 equaled slightly over 322,000 GPD or about 9.821 million gallons per month (MGM). This water was sold to three major water users and about 615 residential and commercial customers, i.e., connections. Over 90 percent of these customers are residential water users. Assuming the Tennessee Office of Water Management's household factor of 2.70 people served per connection for Anderson County, the system serves approximately 1,660 people in the town of Norris. Major water users purchasing water and the average daily amount of water purchased during the first 7 months of 1987 are listed below.

1. Andersonville Utility District (153,000 GPD) to serve 500 customers or about 1,350 people. It should be noted that the Andersonville Utility District currently has a contract with the Clinton Utilities Board to provide its total daily water requirement. However, under normal conditions, Andersonville purchases approximately 50 percent of its normal daily use from the town of Norris for economical reasons and improved water flows and pressure.

2. Tennessee Valley Authority (12,000 GPD) for use at its Engineering Laboratory facilities.

3. State of Tennessee (5,000 GPD) for the operation of park and recreation facilities at Norris State Park.

Per capita water use among this system's users, including those served by the Andersonville Utility District, equals about 101 GPD. This compares to a national average of 100 GPD per capita which is used in the engineering design of public water supply systems.

Peak water use for this system generally occurs during the months of July, August, and September. In many years, May and October are also high water use months. Although the system's average daily water use equals about 322,000 GPD, peak daily use may reach as high as 519,000 GPD.

Analysis of this system's average monthly water use data for the 1972-87 time period provides some basic insights into the system's past growth and development. These insights are summarized below.

1. Average monthly water use during this period ranged from a low of 6.801 MGM during 1974-76 to a high of 9.840 MGM during 1985-87. Thus, average monthly water use during the 1972-87 period increased by 3.039 MGM or 45 percent. Except for minor fluctuations in some years, this increase occurred gradually and was distributed uniformly over the entire period.

2. Disregarding calendar years 1972-73 and 1987 for which only partial records are available, this system's peak water use during the

months of July-September ranged from a low of 7.401 MGM in 1974 to a high of 10.448 MGM in 1983. This represents an increase in peak water use of 3.047 MGM or 41 percent.

3. Total customers served by Norris' public water supply system ranged from a low of 440 customers in 1972 to a high of 672 customers in 1984. Over that time period, the system's growth rate averaged about 20 customers per year. Nonresidential (commercial) water users make up less than 10 percent of the system's total customers.

Based on the foregoing information and data regarding the system's growth and development, it is anticipated that the system will continue to grow at the same relative rate as in the past. More specifically, two basic conclusions are drawn regarding the system's future water use.

1. Assuming an average growth rate of 20 customers per year would result in an increase in water use of about 5,000 GPD. Thus, total average daily water use would increase to about 337,000 GPD by 1990 and 387,000 GPD by 2000.

2. While peak water use is expected to increase at the same relative rate as in the past, the continuing drought conditions could result in higher peak water use due to increased lawn and garden watering and air conditioning.

Water Quality

Chemical analyses are routinely performed on the finished or treated water produced by Norris' water treatment plant in accordance with State and Federal regulations. To date, the results of these analyses have never exceeded any of the maximum contaminant levels, i.e., standards set by existing regulations, for specific water quality parameters. Tables 1, 2, and 3 summarize the established maximum contaminant levels for inorganic (primary) chemicals, organic chemicals, and secondary chemicals and other pertinent factors, respectively, in community drinking water supplies under existing regulations (Tennessee Department of Health and Environment, July 1984).

Table 1

Maximum Contaminant Levels for Inorganic (Primary) Chemicals[1]

Contaminant	Maximum Contaminant Level (mg/l)[2]
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Fluoride	4.0
Lead	0.05
Mercury	0.002

Table 1 (Continued)

Maximum Contaminant Levels for Inorganic (Primary) Chemicals[1]

Contaminant	Maximum Contaminant Level (mg/l)[2]
Nitrate (as N)	10.0
Selenium	0.0
Silver	0.05

1. Primary chemicals are those which can pose health hazards for water consumers. Under existing regulations, public drinking water supplies must be analyzed for the presence of these chemicals once every 3 years. The Norris system's last analysis was done in February 1987.

2. Milligrams per liter - mg/l.

Table 2

Maximum Contaminant Levels for Organic Chemicals[1]

Contaminant	Maximum Contaminant Level (mg/l)
Chlorinated Hydrocarbons	
• Endrin (1,2,3,4,10,10-hexachloro-6, 7-epoxy 1,4,4a,5,6,7,8,8a-octahydro-1, 4-endo, endo-5, 8-di-methano naphthalene)	0.0002
• Lindane (1,2,3,4,5,6-hexachloro-cyclohexane, gamma isomer)	0.004
• Methoxychlor (1,1,1-trichloro-2, 2-bis p-methoxyphenol ethane)	0.1
• Toxaphene ($C_{10}H_{10}Cl_8$-technical chlorinated camphene, 67-69 percent chlorine)	0.005
Chlorophenoxys	
• 2,4-D (2,4-dichlorophenoxyacetic acid)	0.1
• 2,4,5-TP Silvex (2,4,5-trichlorophenoxy-propionic acid)	0.01

1. Norris' public drinking water supplies were analyzed for organic chemicals in November 1981 and none were detected. Therefore, under existing regulations, no further testing has been required by the State.

Table 3

Maximum Contaminant Levels for
Secondary Chemicals and Other Factors[1]

Contaminant	Maximum Contaminant Level (mg/l)
Chloride	250
Color (color units)	15
Copper	1
Methyl blue active substance	0.5
Iron	0.3
Manganese	0.05
Odor (threshold odor number)	3
pH	6.5-8.5
Total dissolved solids	500
Zinc	5
Fluoride	2.0

1. Secondary chemicals and other factors have a major influence on the aesthetic quality of a system's public drinking water supply. Under existing regulations, public drinking water supplies served by groundwater sources must be analyzed for the presence of these chemicals once every 3 years. The last analysis for the Norris system occurred in February 1987.

Past chemical analyses of Norris' public water supply have resulted in the detection of trace amounts of only two primary chemicals--barium and nitrate. Another primary chemical, fluoride, is added to Norris' public water supply for dental hygiene purposes. Existing regulations require all public water systems, which adjust the fluoride content of their water supply, to maintain the concentration of fluoride in the finished water between 0.9 and 1.3 mg/l on the average (Tennessee Department of Health and Environment, July 1984). Results of secondary chemical analyses indicate that the contaminant levels for these chemicals are well below the established maximum contaminant levels. Future amendments to existing State and Federal regulations will require the monitoring of volatile organic chemicals (VOC) starting in 1990. These will include eight regulated VOCs (benzene; carbon tetrachloride; para-dichlorobenzene; 1,2-dichloroethane; 1,1-dichloroethylene; 1,1,1-trichloroethane; trichloroethylene; and vinyl chloride) and 49 other unregulated VOCs including styrene, toluene, xylene, etc.

Existing regulations also require that radiochemicals (gross alpha, gross alpha-2 sigma, etc.) be analyzed once every 4 years. Past results of these analyses have been well below the established limits. The corrosivity of the system's water supply has been analyzed once, as required, (in August 1982) and the water was determined to be moderately aggressive, which is characteristic of groundwater in east Tennessee.

Essentially, the chemical composition of Norris' water supply is very stable and typical of groundwater in east Tennessee. The water is considered to be moderately hard. During the last 15 years, there has been no significant change in the chemistry of Clear Creek Spring's water indicating a reliable groundwater source with no intrusion from surface water sources. Generally, surface waters in Tennessee are less hard and have a lower alkalinity than groundwater. However, the pH, alkalinity, and hardness of surface water may change from day to day and typically does.

The following is a summary of Clear Creek Spring's existing raw water quality for several key water quality parameters based on information and data collected during the summer of 1987.

Parameter	Average Value
pH	7.3
Turbidity	1.0 Nephelometric Turbidity Units
Dissolved oxygen	11.1 mg/l
Alkalinity	140 mg/l
Temperature	15°C

During the year, the pH of Clear Creek Spring's water varies from about 7.3 in the summer to about 7.5 or 7.6 in the winter. To prevent the dissolution of chemical deposits in the system's water distribution lines due to pH differences, the spring water's pH is tested on a daily basis and adjusted, when necessary, through treatment with soda ash in the system's treatment plant to avoid problems. During periods of excessive rainfall, turbidity levels in the spring may rise slightly, but generally they stay below 1.0 Nephelometric Turbidity Units (NTU). Whenever the water's turbidity exceeds two parts per million, alum is added to the water to coagulate the particles so that they can be filtered out by the system's water treatment plant. However, if the turbidity goes above 1.0 NTU, the system's pumps will automatically shut off.

Since this area's geology is karstic (dolomite) in nature, it is possible for surface water and other groundwater sources to intrude on Norris' groundwater supply. Thus, any changes in the chemical composition of Norris' water supply would indicate that something has happened and surface water may be entering Norris' aquifer or groundwater from a different source and is being drawn into Clear Creek Spring. In addition, during extended drought periods, it is possible that the surface of the water table would be lowered exposing previously submerged strata to oxidation which could result in slight increases in mineral concentrations, primarily iron and magnesium. However, it is not anticipated that these increases would pose a significant problem for the town of Norris.

Another potential source of pollution is some septic tanks, less than 10, being used by homes which are located along a road on a ridge about

one-eighth mile above the spring. Due to the region's karstic nature, it might be possible for the flow from the septic tanks' drainfields to reach the spring due to a drop in the spring's water table. Although the Norris Water Commission routinely checks the bacteriological quality (total coliform bacteria) of the system's finished water, the raw water (before chlorination and filtration) is not normally checked.

Recognizing the potential for chemical and bacteriological contamination of the town's groundwater supply, it is recommended that the Norris Water Commission establish a program to test and analyze Clear Creek Spring's raw water supply on a quarterly or monthly basis to develop pertinent baseline information and data regarding the spring's chemical and bacteriological quality. During extended drought periods, beginning with the earliest evidence of the drought, it is further recommended that the frequency of the raw water testing and analysis should be done on a monthly or even a weekly basis. The establishment of this type of program would facilitate the Commission's monitoring of its raw water quality and identification of changes in water quality due to the possible intrusion of surface water or alien groundwater sources.

SYSTEM TO MONITOR AVAILABLE WATER SUPPLIES AND DETERMINE THE POTENTIAL FOR DROUGHT-LIKE CONDITIONS TO OCCUR

The basic cause of drought is a lack of sufficient precipitation. However, even if an area's water supply remains constant, increased use and abuse of water, such as the contamination of existing water supplies, can lead to a water supply shortage. This plan views drought basically within the concept of supply and demand. When supply exceeds demand, particularly during periods with above-normal precipitation, the need for water resources management is usually of little concern to the public. However, when drought occurs water management strategies become highly visible and increasingly important to water users. (Rouse)

The ability to determine or forecast when and where droughts are likely to occur is generally considered to be in its experimental stages. Nevertheless, a very important element of any viable drought management plan is the implementation of a process to monitor and analyze precipitation, maximum and minimum temperatures, lake levels, soil moisture (Palmer Drought Index), etc., in order to identify an occurring drought in a given area. Essentially, this procedure should (1) identify deteriorating water supply conditions as early as possible, (2) build governmental and public awareness of threatening, drought-like conditions and potential future problems, and (3) provide State and local decision-makers, as well as individuals, with the necessary information and adequate lead time needed to take the appropriate actions to deal with the drought in a timely and orderly manner. (Western States Water Council, October 1987) These actions might include the (1) issuance of a drought alert, (2) dissemination of pertinent drought-related information, (3) call for voluntary or mandatory water conservation, (4) institution of water use restrictions for certain nonessential water

uses, (5) identification and evaluation of alternative water supplies, (6) implementation of higher water prices, etc. Currently, the town of Norris has no system or procedure to monitor the flow of Clear Creek Spring. While the Norris Water Commission has a weather station at its treatment plant which collects data on precipitation and daily maximum and minimum temperatures, the Commission has no established system or procedure for analyzing and utilizing this information to monitor available water supplies and determine potential drought conditions. Therefore, it is recommended that the Commission should review and summarize all precipitation and temperature data collected on at least a yearly basis; display it, as appropriate, in graphic form; and correlate it with pertinent information relative to the quantity and quality of water available from Clear Creek Spring in order to establish a data base on the area's environmental conditions and water supply availability. It is further recommended that the Commission collect data on soil moisture (Palmer Drought Index) conditions on at least a monthly basis and incorporate it, as appropriate, into the data base on area environmental conditions. To facilitate the establishment of a long-term (30 plus years) data base that would include the 1953-1954 drought, it is suggested that, to the extent possible, similar data should be collected for the 1950-1987 time period and incorporated into the data base. Essentially, all or most of this data would be available from the National Weather Service (precipitation, temperature, and Palmer Drought Index data). Establishment and maintenance of this data base would provide a basis for the Norris Water Commission to monitor available water supplies, determine potential drought conditions, and establish guidelines or "trigger points" for the implementation of specific measures to alleviate drought-related water supply shortages.

While it is recognized that the data base on environmental conditions will not provide the basic information needed to determine exactly how Clear Creek Spring's flow would be affected or the timing of that effect as a result of changing environmental conditions, it seems reasonable to assume that such data would provide some general guidance and direction to system personnel regarding general trends which could be anticipated in the spring's flow. However, to facilitate improved monitoring and management of the system's available water supply, it is recommended that the Norris Water Commission consider installing, if feasible, an observation well in Clear Creek Spring to monitor the spring's water table elevation.

PHASED RESPONSES TO REDUCTIONS IN SUPPLY

To respond effectively and appropriately to progressively worsening drought situations, Norris' local drought management plan provides for three basic levels of service or response phases under increasingly severe drought conditions. Specifically, these phases include the "conservation," "restrictions," and "emergency" water supply shortage phases. Essentially, each phase is a function of the percent reduction in overall water use for public supply purposes required to (1) reduce existing and future water use to the available water supply and (2) protect the water resource from serious or irreparable damage. Specific

water use reductions required under each phase are "conservation" (15 to 20 percent), "restrictions" (30 to 40 percent), and "emergency" (60 percent or more).

For each water shortage phase, this plan identifies (1) a "trigger point" to alert system personnel that the drought is worsening and call for the implementation of the successive response phases to varying degrees of water supply shortage and (2) specific restrictions or measures that will be taken to achieve the required percent reduction in water use. Individual "trigger points" and water use restrictions identified for each response phase are summarized briefly below.

1. "Conservation" Phase. This phase calls for a 15 to 20 percent reduction in water use. Two occurrences would "trigger" the implementation of this phase's measures to reduce water use: (a) a drop in the annual precipitation recorded at the weather station at Norris' water treatment plant below 50 percent of normal for an average year and (b) the complete cessation of overflow from Clear Creek Spring. Either of these occurrences would result in the Norris Water Commission's request for voluntary conservation on the part of its customers to reduce water use and cut back water sales to the Andersonville Utility District from about 153,000 GPD (1987 average daily purchase) to 130,000 GPD. In addition, homeowners would be encouraged to install water-saving devices and repair household leaks.

2. "Restrictions" Phase. Reductions in water use required during this phase would equal 30 to 40 percent of normal water use. The implementation of this phase's measures to reduce water use would be "triggered" by a sudden drop in flow from Clear Creek Spring to 235 GPM. Under this phase, the Commission would implement several measures to reduce water use.

   - Mandatory water conservation measures would go into effect for all nonessential and "second and third class" essential water uses.

   - The sale of water to the Andersonville Utility District would be cut from about 153,000 GPD (1987 average daily purchase) to 100,000 GPD.

   - In addition, pressure-reducing devices would be installed in the system's main lines and measures would be established to enforce water conservation measures including fines and/or penalties for excessive water use.

3. "Emergency" Phase. During this phase, water use would be reduced by 60 percent or more. The "trigger point" for this phase would be a drop in Clear Creek Spring's flow to 150 GPM or less. Specific measures to be implemented during this phase to reduce water use and alleviate potential supply shortages include the following:

   - Expansion of mandatory water conservation to include all "first class" essential uses and the continuation of enforcement measures to reduce water use.

- Water sales to Andersonville Utility District would be cut from about 153,000 GPD (1987 average daily purchase) to 75,000 GPD.

- An emergency water intake would be located in the Clinch River at river mile 78.11. Water withdrawals from the Clinch River would either be pumped back to the system's original treatment plant and/or the Norris Water Commission would purchase a "package" type treatment unit and install it near the Clinch River intake or adjacent to the existing water treatment plant.

Normally, the Andersonville Utility District purchases about 150,000 GPD from the Norris Water Commission. Whenever the Commission reduces the sale of water to the District, the District makes up the difference by purchasing additional water from the Clinton Utilities Board.

One of the principal measures to be used under each of these phases to achieve the desired reduction in water use is that of conservation. Essentially, this involves voluntary and/or mandatory cutbacks in customers' water use for both indoor and outdoor water uses. Conservation measures which should be considered in reducing indoor water use include flushing the commode fewer times, taking shorter showers and shallower baths, using dishwashers and washing machines only with full loads, turning the shower off while soaping or shampooing, and keeping a bottle of chilled drinking water in the refrigerator. Outdoor water uses which can be reduced significantly through conservation include the watering of lawns, gardens, and trees and shrubs; filling of swimming pools; and washing of cars. Research by the Virginia Water Resources Research Center indicates that the success of a program to conserve water depends on (1) the public's perception of the program's fairness and (2) the existence of thorough public information and education programs to inform water users of the potential for drought and its seriousness and delinate viable water conservation measures. (Keck, June 1988)

Realizing the importance of public information and education in implementing an effective water conservation program, it is recomended that the Norris Water Commission review its present public information and education program from the standpoint of the program's usefulness in informing the system's customers of the potential for drought-related water supply shortages and describing alternative measures for conserving water. If necessary, the Commission should consider modifying or expanding its existing program, as appropriate, to facilitate its utilitarian value in dealing with drought-related water supply shortages in a timely and orderly manner.

WATER USE PRIORITIES

An important element of any drought management plan is the development of a classification system of water uses to reflect local water use priorities. A classification system is important because it clarifies issues of fairness, hardship, and, ultimately, management effectiveness.

In addition, the classification of water uses also facilitates the system's identification of (1) its water use goals, priorities, and strategies and (2) weaknesses of the drought management plan. In classifying water uses, the supplier should consider all available management options including increased water prices, water conservation, supplemental and/or backup water supplies, bans or restrictions on water use, etc. (Keck, June 1988)

Currently, the majority of customers served by the Norris Water Commission are residential water users. In addition, the Commission also sells water to the Andersonville Utility District (153,000 GPD), Tennessee Valley Authority (12,000 GPD), and State of Tennessee (5,000 GPD). At the present time, there is only one private business--a nursery--that would probably be affected by any reductions in water supply if mandatory water conservation measures were not successful in achieving the necessary reductions in water use.

Norris' local drought management plan has identified two basic classifications of water use--essential and nonessential--with essential water uses being broken down into "first," "second," and "third" class essential uses. Summarized below is a listing of the specific water uses included in each classification for the Norris public water supply system. Individual water use classes and the uses delineated within each class are listed in order of their relative use priority, i.e., the water uses are listed from highest to lowest priority.

1. Essential "First Class" Water Uses

   - Domestic. Water use to sustain human life and the lives of domestic animals and to maintain minimum standards of hygiene and sanitation, excluding laundry.

   - Health Care Facilities. Water use for patient care and rehabilitation, including related pool operation. Currently, the town of Norris has no health care facilities.

   - Public Supply. Water use for two basic purposes: firefighting and health and public protection purposes, including line flushing on an emergency basis.

2. Essential "Second Class" Water Uses

   - Domestic. All uses not included in "First Class."

   - Agricultural. Water use by commercial nurseries at the minimum level necessary to maintain stock, to the extent that sources of water other than fresh water are not available or feasible to use. Norris' public water supply currently serves only one nursery.

   - Industrial. Water use for industrial processes and industrial air conditioning. No industrial or manufacturing facilities are being served by Norris' water supply system at the present time.

- Commercial. Water use for offices, retail and entertainment facilities, restaurants, hotels and motels, laundromats, etc.

3. Essential "Third Class" Water Uses

   - Schools and Churches. Water use for human and sanitary purposes.

   - Motor Vehicle Washing. Water use for commercial car and truck washes. Currently, the town of Norris has no commercial car or truck washes.

   - Swimming Pools. Water use for municipal and residential pools serving more than 25 dwelling units.

4. Nonessential Water Uses

   - Outdoor Noncommercial. Water use for irrigating gardens (except handheld), lawns, parks, golf courses (except greens), playing fields and other recreation areas, and street washing.

   - Ornamental. Water use for fountains, reflecting pools, and artificial waterfalls. Currently, Norris' public water supply system provides no water for ornamental purposes.

   - Swimming Pools. Water use for private pools serving less than 25 dwelling units.

   - Motor Vehicle Washing. Water use for the washing of privately owned cars and trucks.

Table 4 delineates the recommended water use classes and class restrictions for dealing with varying degrees or phases of water supply shortages through the implementation of various voluntary and/or mandatory cutbacks or bans on specific water use classifications (Wood and Others, May 1986). However, it does not reflect other drought mitigative measures (alternative or backup sources of supply, repair of leaking water mains and distribution lines, price increases, etc.) that might be considered for implementation by Norris' officials in addition to the general measures shown.

Table 4

Recommended Water Use Classes and Class Restrictions

General Water Use Class	Phased Responses to Water Supply Shortages		
	Conservation	Restrictions	Emergency
Essential "First Class"	Voluntary Cutbacks	Voluntary Cutbacks	Mandatory or Voluntary Cutbacks
Essential "Second Class"	Voluntary Cutbacks	Mandatory or Voluntary Cutbacks	Mandatory Bans

Table 4 (Continued)

Recommended Water Use Classes and Class Restrictions

General Water Use Class	Phased Responses to Water Supply Shortages		
	Conservation	Restrictions	Emergency
Essential "Third Class"	Voluntary Cutbacks	Mandatory Bans	Mandatory Bans
Nonessential	Mandatory Cutbacks or Bans	Mandatory Bans	Mandatory Bans

In the water "conservation" and "restrictions" programs, essential "first class" water uses should always be provided for. This drought management plan emphasizes curtailing one class of uses before strong measures are implemented to significantly cut the next higher water use classification.

IDENTIFICATION AND EVALUATION OF ALTERNATIVE SOURCES OF SUPPLY

An integral part in the process of developing this drought management plan was the identification and evaluation of specific measures, including alternative and/or backup sources of supply, which the system might consider for implementation in dealing with drought-related water supply shortages. This portion of the plan describes and evaluates a number of potentially appropriate measures which the Norris Water Commission might consider utilizing to alleviate water supply shortages. Basic information provided in this section is presented as food for thought to stimulate discussion and thinking about specific measures which have the potential to reduce existing and future water use and/or increase available water supplies to meet Norris' water-related demands.

Water Conservation

One effective and inexpensive way the town of Norris can deal with drought is through conservation. Conservation is a broad, general term which encompasses within its meaning a number of specific actions including public information and education, water-user ordinances, recycling, water-use rates, repair and maintenance of deteriorating water supply systems, and evaporation suppressants. However, conservation entails more than specific remedies. To be fully effective, water conservation techniques must be understood and accepted by the public.

When water shortages occur or drought conditions prevail, conservation of water should be the number one priority. Utilization of practical conservation measures can save an enormous amount of water, since most American families waste between 40 and 60 percent of their daily water demand through carelessness (Ferrell and Others, July 1984). However,

bringing about a long-term change in people's water-using habits is difficult to effectuate and maintain, particularly during periods when water supplies are plentiful. This can be accomplished most effectively through the conscientious education of young people, beginning in the elementary grades, about water and its value, drought and its effects, and effective water conservation measures. Continuous education through the news media and conservation pamphlets, enclosed with monthly utility bills, is another way of increasing public awareness of the need for conserving water.

Another important step in conserving water is for local water officials to work closely with community leaders, particularly planners and developers, prior to drought periods to plan for and implement specific measures to reduce residential water use. Recent studies have indicated that showers utilize 30 percent of total household water, toilets about 40 percent, and faucets 10 percent, with the remaining 20 percent being used for nonessential or outdoor purposes (Ferrell and Others, July 1984). The use of conservation devices in the average household or commercial operation could result in a 50 percent savings of the total amount of water used for the foregoing purposes. In addition, the use of conservation devices provides a significant savings in the power costs associated with heating water and the cost of sewage treatment. This could be accomplished through the utilization of economic incentives, such as water pricing policies, that would encourage water conservation and enforcement of building code provisions that mandate the use of water saving devices.

It should be noted that whenever water users are encouraged to conserve water, they should also be informed of the potential health-related issues and concerns resulting from the direct utilization of water from the taps. That is, turning on the tap and beginning to use the water immediately without running it for a minute or so to flush out the water which has been standing in the water lines for an extended period of time. Most homes, especially those less than 5 years old that have copper plumbing and lead soldering, will experience some increase in lead concentrations in water which stands in the pipes for any extended period of time, even overnight. To minimize this potential, water users should be encouraged to run the water long enough to flush out the water lines prior to any water use for drinking or cooking purposes.

Repair of System and Household Leaks

Water systems can lose up to 50 percent or more of their treated water supply due to leaks in their service and distribution lines. Recent estimates, developed by the Pittsburgh Equitable Meter Company, indicate that at 60 pounds of pressure the water losses shown on the following page can be expected from system leaks over a 3-month period.

Ordinarily, a good tight water supply system will lose no more than 10 to 15 percent of its treated water and the Norris public water supply system almost always falls within this range. The low water loss from Norris' system is a direct result of the system's ongoing leak detection and repair program. Limited additional attention could be given to this activity.

Size of Hole (Inch)	Water Loss (Gallons)
1/4	1,200,000
3/16	675,000
1/8	300,000
1/16	75,000
1/32	19,000

Increasing Consumer Water Costs Through Rate Structure Modification

During recent years, water resources managers have come to recognize that water is an economic resource whose true value or worth must be recognized and priced accordingly. Consequently, Norris should (1) review its existing rate structure to determine if the full cost of providing and maintaining adequate water services is being recovered and (2) determine if the existing rate structure is conducive to promoting the wise use and efficient management of the system's source of supply. (Moreau, 1984)

Currently, the Norris public water supply system charges a fixed rate of $2.14 per 1,000 gallons of water used, with a minimum bill of $6.42 per month for the first 3,000 gallons used. Customers using more than 3,000 gallons per month are charged $2.14 for each additional 1,000 gallons of water used, with no limit on the total amount of water used. Since most of the system serves residential users, the Norris Water Commission feels that its fixed rate schedule, rather than the decreasing block rate, is more likely to encourage the system's customers to conserve water.

However, another rate structure which would offer even greater incentives to conserve water is the increasing block rate pricing structure. This represents the exact reverse of the decreasing block rate structure in that the unit rate increases with each succeeding block of water used. Generally, this type of rate structure offers the greatest incentive to reduce water use.

Metering

In accordance with good system management, Norris' public water supply system is completely metered. The meters are read on a regular basis and the meter boxes are kept clean and dry wherever possible. There seems to be no evidence of water theft by meters being bypassed or disconnected.

As water meters age, they begin to wear out and allow more water to pass through the meter than registers on the dial. Thus, the customer pays less for the water used resulting in a loss to the system. To prevent or minimize water losses of this nature, the Norris Water Commission has established a schedule for testing all meters on a regular basis and replacing those which are worn out.

Pressure Reduction

During periods of water supply shortages, be they drought induced or otherwise, one measure Norris can use to conserve water is to reduce the water pressure in the entire system, in part of the system, or to individual services. Decreasing the water pressure diminishes the amount of water flowing through open faucets. Normally, 50 pounds per square inch (PSI) is considered sufficient water pressure for residential purposes; however, pressures exceeding 80 PSI are not uncommon in many systems. Under normal conditions, Norris' water pressure ranges from 60 to 240 PSI.

Alternate Sources of Supply

Another option for dealing with periods of limited water availability or extended drought conditions is for the town of Norris to supplement its existing source of supply from other sources or find a new one. This would be particularly true during the period of peak water use from May through October which is often characterized by below normal precipitation and above average water use due to air conditioning, increased lawn and garden watering, etc. Recognizing that Norris' water use during dry periods is already approaching the capacity of Clear Creek Spring, its sole source of supply, an alternative or supplemental source of supply will be needed within the very near future. Basically, there are several alternatives that the Norris Water Commission might consider to supplement or replace its existing source of supply. Each of these alternatives is described briefly below.

1. Clinch River and Norris Reservoir. The most feasible alternative would be for the system to run a direct line to the Clinch River at river mile 78.11, a distance of about 5,800 feet, or to Norris Reservoir, a distance of about 7,600 feet. Either of these sources would provide Norris with a reliable source of good quality water that would not require additional water treatment facilities at the present treatment plant. Water from either of these sources is quite comparable and similar in quality to that from Clear Creek Spring.

2. Clinton Utilities Board. In the event that Clear Creek Spring should fail completely leaving the town of Norris without any water, a small portion of Norris' water demand could be supplied by the Clinton Utilities Board through its connection with the Andersonville Utility District, which currently receives a large part of its daily water supply from the Norris system. This water would come from Clinton's two million gallons per day treatment plant on the Clinch River and be transported to the Norris system through Andersonville's hookup with the Norris water system following renovation of a pumping station and water meters at Andersonville's connection with the Clinton Utilities Board to increase their capacity enough to allow water to be pumped from Clinton to Norris' water storage facilities. However, the connecting line sizes between Clinton and Andersonville and Andersonville and Norris are too small to supply all of the water needed by both the Andersonville Utility District

and the town of Norris. Essentially, this alternative could be used primarily to serve some of the system's smaller, low-lying areas. However, to facilitate the utilization of this alternative in a timely and orderly manner should the need arise, it is recommended that the town of Norris reach an agreement with the Andersonville Utility District and Clinton Utilities Board regarding the amount of water and circumstances under which that water would be provided to the town of Norris.

3. Expansion of the System's Treatment Plant and Storage Capacity. Although not an alternate source of supply, this option would enhance the system's overall dependability in terms of providing adequate water supplies during peak use periods and for a minimum period of time during severe and extended periods of drought. As noted earlier, the system's current maximum treatment plant capacity of 520,000 gallons per day barely exceeds the system's peak daily use of 519,000 gallons per day and the current treated water storage of 350,000 gallons exceeds the system's average daily use by less than 10 percent. Expansion of both of these facilities is badly needed to reduce the risk of water supply shortages and accommodate anticipated growth. However, any plans for system expansion should be closely coordinated with the system's search for alternative supply sources to ensure that the expanded treatment plant can provide adequate treatment for any alternative sources of supply. Currently, the Norris Water Commission is meeting with its consulting engineer to discuss plans for developing additional sources, expanding the system's treatment plant capacity, and increasing its storage capacity for treated water.

4. Additional Wells. Another potential source of water for the town of Norris lies in the area's potential for additional groundwater development. While the Norris public water supply system currently has no standby wells for emergency use, the possibility of locating and drilling additional wells to supplement Norris' existing supply is considered to be good. To facilitate the location and selection of the best possible well sites, it is recommended that a competent geohydrologist be hired by the town. Because of the time required to locate, construct, and develop a well, this should be done prior to an emergency.

Conjunctive Water Use

Conjunctive water use, i.e., the utilization of both surface water and groundwater resources to serve an area's water supply needs, poses a very real and viable option for the town of Norris to consider in planning for and dealing with water supply shortages should they occur. As has already been noted, one of Norris' most viable options for dealing with such shortages is to look to the Clinch River as an alternate source of water. However, in the interest of long-term dependability for Norris' water supply, Norris should continue to utilize its present source--Clear Clear Spring--to its maximum capacity and supplement it as necessary with water from the Clinch River.

As has been noted earlier, the quality of water available from both of these sources is good and should pose no problems in terms of Norris'

present water treatment plant providing adequate treatment for the Clinch River water. While the water from the river will be colder and probably have less dissolved oxygen than the spring, it will also have less turbidity during the winter months. Both sources would probably experience sharp increases in turbidity levels during periods of heavy rainfall.

Whenever surface water and groundwater supplies are used conjunctively and mixed together, the potential exists for some water quality-related problems to occur. Essentially, these problems manifest themselves through the (1) release of scaly deposits in the system's water distribution lines and (2) discoloration of the water delivered to users. Neither of these is expected to pose a problem for the Norris public water supply system. The rationale for assuming this follows.

1. Release of Scaly Deposits in Distribution Lines. A difference in pH between conjunctively used surface water and groundwater supplies may cause earlier deposits in water distribution lines to be released resulting in serious problems such as stained laundery in customers' homes and residue in wash basins. Analysis indicates that the pH of Clear Creek Spring's water varies from about 7.3 in the summer to about 7.5 or 7.6 in the winter, while the pH of the Clinch River remains at about 7.4. Since there are no appreciable deposits in the distribution pipelines of the Norris system and the pH differential can be adjusted at the system's treatment plant via the introduction of soda ash, no problems of this nature would be anticipated as a result of the conjunctive use of available water supplies.

2. Water Discoloration. In some areas, existing groundwater supplies may contain ferrous oxide which is colorless. When this water enters the water system and is exposed to the air, carbon dioxide is released and ferrous iron is changed to ferric iron, which then precipitates out of solution causing the water to become reddish in color. However, this is not expected to pose a problem for the Norris system since its groundwater supply contains little or no ferrous oxide.

Water Reuse and Recycling

Water reuse is not a new concept. Most of the water available to users has been "used" over and over again for centuries. Whenever we use water in our daily activities, we are participating in water reuse. This stems from the fact that all of the water available to us today has been used and reused again and again thanks to the hydrologic cycle, nature's world-class and world-size reuse system. All of the water we drink, flush, or water our lawns with re-enters the water system sooner or later, cleaned either by nature or human processes, to be used again. (The Freshwater Society, 1986/87)

During periods of drought, planned water reuse should be considered. For Norris, the reuse of water may be particularly critical during a time of severe drought. Water users served by Norris' system could find it beneficial to use bath and laundry water to water lawns and shrubs, heavy cleaning jobs such as floors, and washing cars.

Considerable progress has been made in recent years in the development of specific products and equipment to make home water reuse more practical. For example, low-sudsing, biodegradable detergents are now available for many laundry and household cleaning jobs resulting in much cleaner rinsewater that could be used for the aforementioned purposes. In addition, there have been some research and demonstration projects for the development and use of home water recycling units. Generally, these demonstrations of home treatment units have been quite successful in recycling all home water use, except that used for sanitary purposes.

SELECTED DROUGHT MANAGEMENT PLAN FOR NORRIS, TENNESSEE

Basically, Norris' local drought management plan outlines the specific actions that the Norris Water Commission will take in order to deal with water supply shortages during a drought period, as quickly and effectively as possible. These actions are summarized briefly below.

1. Continuation of the system's program to (a) identify and repair leaking water mains and distribution lines and (b) replace old, worn out meters.

2. As in the past, conservation will continue to be the system's primary method for dealing with real or potential water supply shortages, be they drought-related or otherwise. Depending on the degree or magnitude of the shortage, sales of water to wholesale customers outside the town of Norris would be curtailed and system users would be requested to conserve water on either a voluntary or mandatory basis. In all cases, system users would be requested to curtail "non-essential" water uses first, followed by further conservation of "essential" water uses beginning with the "third class" uses and extending, if necessary, to the "first class" uses under emergency conditions. If necessary, mandatory conservation might be enforced by adding penalties to monthly water bills for excessive use.

3. Continuation and expansion of the system's public information program, as necessary, to inform the public about the status of the area's water resources, the potential for water supply shortages, and the need to conserve water during dry periods.

4. Recognizing the system's potential for serious supply shortages during dry conditions due to the decrease in Clear Creek Spring's flow, the Commission will review and evaluate the individual supply alternatives identified in the preceding section of the plan and utilize these, as appropriate, to supplement or take the place of Clear Creek Spring, thereby providing a more reliable or dependable source of supply.

5. The Commission will also consider all plan recommendations and implement those deemed pertinent to maintaining the Commission's ability to provide its customers with an adequate supply of good quality water.

As decisions are made by the Commission to utilize alternative sources of supply and/or implement specific plan recommendations, these decisions will be noted and incorporated, as appropriate, into Norris' selected drought management plan during future revisions and plan updates.

Under current circumstances, the following actions would be taken by the Commission, whenever Clear Creek Spring begins to show signs of reduced water flow, to conserve water for domestic, commercial, and fire protection purposes. The number of actions taken would depend on the seriousness of the condition. Specific actions are listed below in the probable order that they would be used.

1. Voluntary conservation and reduction of water sales to wholesale customers outside the town of Norris.

2. Restrictions on certain activities such as car washing and lawn sprinkling.

3. Mandatory conservation. This might be accomplished through the addition of penalty charges to monthly water bills for those users exceeding a prescribed monthly amount of water use.

4. Further reductions in water sales to wholesale customers.

5. Acquisition of additional water supplies via temporary supply lines to the Clinch River or to Norris Lake.

PLAN IMPLEMENTATION ORDINANCE NO. 359

To deal effectively with drought-related water supply shortages, the Norris Water Commission developed a proposed ordinance in February 1988 which formalizes the Commission's authority to implement certain basic actions during emergency water supply shortages to encourage water conservation and prohibit nonessential and some "second" and "third class" essential water uses. More specifically, this ordinance will, when approved and adopted, give the Commission the authority to encourage water users to conserve water, prohibit or regulate the use of water during a water supply emergency, provide for notice and penalties for water use violations, and repeal all ordinances or portions of ordinances which are in conflict with this ordinance. Appendix III contains a copy of the proposed ordinance which passed the first of three readings on May 9, 1988.

It is recommended that, as time passes, the Commission consider reviewing the ordinance with regard to incorporating into it (a) pertinent references to Norris' local drought management plan, (b) pertinent plan features, and (c) additional enabling authority, if necessary, to facilitate Norris' implementation of pertinent plan actions or recommendations to alleviate or resolve drought-related water supply shortages.

PLAN ENFORCEMENT

Depending on the degree or severity of the shortage--conservation, restrictions, or emergency phase--the need for an appropriate enforcement mechanism varies greatly. For example, when the measures being implemented are voluntary in nature, the need for an enforcement mechanism is not necessary. Under voluntary conservation requests, the Commission's customers are asked not to use water for lawn and garden watering, car washing, and other unnecessary purposes.

However, some form of enforcement mechanism is needed when existing water shortages necessitate the use of mandatory conservation, water restrictions, or emergency actions to achieve the desired reductions in water use. Section 1, Part 13-305; Enforcement; Ordinance No. 359; provides that mechanism:

> Every police officer of the City shall in connection with his duties imposed by law, diligently enforce the provisions of this Ordinance. The City Manager shall have the authority to enforce the provisions of this Ordinance by the discontinuance of water service in the event of violation hereof in addition to the penalties set out herein above.

During severe and extended drought periods, customers not complying with Commission requests for mandatory conservation may find an increase in their monthly water bill due to the addition of penalty charges for excessive use. Under "emergency" phase conditions, i.e., when water use must be reduced by 60 percent or more, water is to be used only for "first class" essential uses.

If, for some reason, Norris' response to severe and extended drought conditions and water supply shortages is inadequate, the Tennessee Office of Water Management would have the authority, either independently or through a concurring declaration of emergency by the Governor, the Tennessee Emergency Management Agency, and the Tennessee Department of Health and Environment, to (1) assist in the implementation of pertinent actions and (2) if necessary, mediate or resolve water use conflicts between competing users including the protection of the environment. In the event of a "declared" emergency, the Tennessee Office of Water Management might have to allocate water among the competing users. The authority for this power is found under various statutes and Executive Order including the Civilian Defense Act, T.C.A. Sections 58-2-101 through 58-2-518; the Water Quality Control Act, T.C.A. Section 69-3-109(b); the Safe Drinking Water Act, T.C.A. Section 68-13-710; and Executive Order No. 4. (Keck, January 1987)

LOCAL WATER SHORTAGE MANAGEMENT TASK FORCE

To date, no water shortage task force has been established by the town of Norris to participate in and provide input to the development of Norris' local drought management plan. The current plan was developed

through a joint, cooperative effort involving the Norris Water Commission; Tennessee Department of Health and Environment, Office of Water Management (Nashville and Knoxville offices); and Tennessee Valley Authority, Office of Natural Resources and Economic Development. It should be noted, however, that the establishment and maintenance of such a group can be of invaluable assistance to local communities during periods of severe and extended drought, particularly communities that experience water supply shortages on a regular basis or communities whose available source of supply has decreased drastically.

Basically, the function of such a task force would be to (1) participate in the development and periodic revision and update of a community's basic plan for responding to drought-related water supply shortages and (2) assist system personnel in the implementation of specific plan actions and for recommendations to deal with water supply shortages when they occur. An important role played by the task force is that it serves as a consensus-building group so that the group's decisions will have the community's general support. Once decisions are made, task force members can also assist in program implementation including fund-raising for the distribution of conservation products, organizing volunteers to serve the elderly and handicapped in potential water cutoff areas, and enlisting volunteers to enforce any mandatory conservation measures which the city feels are necessary. The following is a list of potential sources for task force members.

City/County Health Department Officials
City Administration
Churches and Schools
Fire Chief
Local Media Representatives
Professional Groups
City Water Superintendent and Personnel
Commercial/Industrial/Institutional Water Users
Conservation Groups

Recognizing the many roles that a task force of this nature could play in terms of developing general support for a community's drought management plan and achieving the implementation of specific plan elements on a timely basis to alleviate water supply shortages, it is recommended that the Norris Water Commission give consideration to the establishment of such a task force to facilitate plan implementation, as appropriate, and future plan revisions and updates.

PLAN UPDATE AND REVISION

An integral element of any viable drought management planning process is the need to periodically update and revise the plan itself to reflect changing circumstances relative to both water availability and use. Current plans call for Norris' local drought management plan to be reviewed and revised, if necessary, at 2-year intervals, unless changes occur that would necessitate more frequent revision. Included among these factors or changes are population and/or industrial growth, changes

in industrial mix, lower risk requirements of the users being served, infrastructure condition, etc. Other changes that might require revision of the plan would include the availability of additional quantity/quality information on Clear Creek Spring, major changes in the water system's basic facilities, and administrative and/or organizational changes in the structure of the Norris Water Commission. In addition, plans might need to be revised to address needs which were previously overlooked, delete inappropriate triggering points, etc.

Future annexations in the Norris area may drastically change the system's service area, thereby necessitating the need to update and revise Norris' local drought management plan. For example, Clinton may annex all areas up to I-75 which are currently being served by the Andersonville Utility District. If that happens then those areas would be served by the Clinton Utilities Board. There is also a possibility that the Norris Water Commission would then take over and serve those areas located closest to Norris which were previously served by the Andersonville Utility District.

PLAN RECOMMENDATIONS

Summarized below by major category or topic are the plan recommendations contained in the preceding sections of this plan.

Public Education

1. Recognizing the importance of public education in effective water supply management coupled with the 40 percent decrease in Clear Creek Spring's average flow in recent months and the continuing drought, it is recommended that the Norris Water Commission give consideration to establishing and undertaking a program designed to inform and educate the public about the area's water resources, the potential for water supply shortages, and the importance of water conservation.

Replacement of Galvanized Steel Pipelines

1. Recognizing that the Tennessee Department of Health and Environment no longer approves of the use of galvanized steel pipelines due to complaints of rusty and "red" water problems, it is recommended that the Commission give consideration to replacing lines made of galvanized steel by polyvinylchloride or "type K" copper tubing, as time and finances permit.

Expansion of the System's Water Treatment Plant

1. Since the system's average daily water use (320,000 GPD) is almost equal to 80 percent of the system's design treatment plant capacity (432,000 GPD) and the system's peak water use (519,000 GPD) is virtually equivalent to the system's maximum treatment plant capacity (520,000 GPD), it is recommended that the Norris Water Commission

evaluate the potential for increases in both the average daily and peak water use and begin to plan for and implement, as appropriate, the expansion of the system's treatment plant capacity. Any decision to expand the system's treatment plant capacity should also consider the system's current treatment capability and make any modifications necessary to facilitate the plant's ability to provide adequate treatment for any additional or alternative water supplies (Clinch River, Norris Reservoir, etc.) which the system might utilize at some point in the future to reduce the risk of water supply shortages and meet increasing demands.

Analysis of Clear Creek Spring's Pollution Potential

1. Since the extent and precise location of Clear Creek Spring's recharge area is unknown, it is recommended that the town of Norris undertake a program to (a) more accurately delineate Clear Creek Spring's recharge area through the conduct of groundwater tracer experiments and collection of pertinent hydrogeologic data, (2) identify and analyze the basic land uses occurring within the spring's defined recharge area, and (3) monitor the impacts, if any, of these land uses on the spring's water quality. Once the spring's recharge area has been clearly defined and its relative susceptibility to pollution determined, the Norris Water Commission should proceed to (1) identify and implement, as appropriate and feasible, those measures which would minimize, to the extent possible, the pollution potential from existing land uses in the recharge area and (2) limit future development in the recharge area to those land uses which would not adversely impact the spring.

Water Quality Analysis and Monitoring

1. In view of the potential for chemical and bacteriological contamination of the town's groundwater supply, it is recommended that the Norris Water Commission establish a program to test and analyze Clear Creek Spring's raw water supply on a quarterly or monthly basis to develop pertinent baseline information and data regarding the spring's chemical and bacteriological quality. During drought periods, it is further recommended that the frequency of the raw water testing and analysis should be done on a monthly or even a weekly basis to facilitate the identification of changes in water quality.

Monitoring Water Availability

1. Since the Norris Water Commission has no established system or procedure for monitoring available water from Clear Creek Spring, it is recommended that the Commission should review and summarize all precipitation and temperature data (maximum and minimum) being collected at the system's water treatment plant, display it in graphic form, and correlate it with pertinent information on the quantity and quality of water available from Clear Creek Spring to establish a data base on environmental conditions in the Norris area and water supply availability. In addition, it is recommended that the Commission collect data on soil moisture (Palmer Drought Index)

conditions on at least a monthly basis and incorporate it into the environmental data base. It is also suggested that similar environmental data should be collected for the 1950-1987 period and incorporated into the data base. Establishment and maintenance of this data base would facilitate the Commission's monitoring of available water supplies, determination of potential drought conditions, and establishment of guidelines or "trigger points" for the implementation of specific measures to mitigate against a potential water shortage.

2. Recognizing that a data base on environmental conditions will not enable the Norris Water Commission to determine exactly how changing environmental conditions would affect Clear Creek Spring's flow, it is recommended that Norris consider installing an observation well in Clear Creek Spring to monitor its water table elevation.

Water Conservation

1. Realizing the importance of public information and education in implementing an effective water conservation program, it is recommended that the Norris Water Commission review its present public information and education program from the standpoint of the program's usefulness in informing the system's customers of the potential for drought-related water supply shortages and describing alternative measures for conserving water. If necessary, the Commission should consider modifying or expanding its existing program, as appropriate, to facilitate its utilitarian value in dealing with drought-related water supply shortages in a timely and orderly manner.

Alternative Water Supplies

1. To facilitate the acquisition of water from the Clinton Utilities Board, it is recommended that the town of Norris reach an agreement with the Andersonville Utility District and Clinton Utilities Board regarding the amount of water and circumstances under which that water would be provided to the town of Norris.

2. To assure the location and selection of the best possible well sites for the development of additional or supplementary water supplies for the town of Norris, it is recommended that the town acquire the services of an experienced, knowledgeable geohydrologist.

Plan Implementation Ordinance No. 359

1. It is recommended that, as time passes, the Commission consider reviewing the ordinance with regard to incorporating into it (1) pertinent references to Norris' local drought management plan, (b) pertinent plan features, and (c) additional enabling authority, if necessary, to facilitate Norris' implementation of pertinent plan actions or recommendations to resolve or alleviate drought-related water supply shortages.

Local Water Shortage Management Task Force

1. Recognizing the many roles that a task force of this nature could play in terms of developing general support for the community's drought management plan and achieving the implementation of specific plan elements on a timely basis to alleviate water supply shortages, it is recommended that the Norris Water Commission give consideration to the establishment of such a task force to facilitate plan implementation, as appropriate, and future plan revisions and updates.

PLAN GLOSSARY

The following terms are defined as they are used in Norris' local drought management plan.

Alternate Sources of Supply--This refers to other sources of water supply (Clinch River, groundwater wells, etc.) and/or measures (water conservation, increased water rates, etc.) which could be utilized by the town of Norris to supplement or, if necessary, replace available water supplies from Clear Creek Spring.

Aquifer--A geologic formation, group of formations, or part of a formation that contains sufficient water-saturated permeable material to store, transport, and yield significant quantities of water to wells and springs.

Average Daily Water Use--The average amount of water withdrawn from Clear Creek Spring for processing and distribution through Norris' public water supply system to meet the system's daily water demands. This amount is usually based on the system average monthly use over a 12-month period and is recorded in gallons or millions of gallons per day.

Conservation Phase--This refers to a water supply shortage situation characterized by deteriorating water quality and possible conflicts among various water user groups. Alleviation of this situation in Norris' drought management plan would require a 15 to 20 percent reduction in water use.

Contaminant--Any physical, bacteriological, chemical, geological, or radiological substance or matter in water.

Drought--A period of time characterized by below normal or no precipitation (rain or snow) and one or more of such conditions as depleted soil moisture, decreased streamflow, reduced lake or reservoir storage, deteriorating water quality, and lowered groundwater levels. The longer this situation exists, the more serious the drought becomes.

Drought Alert--A term used to warn or advise an area that it is experiencing lower than normal precipitation, streamflows, and reservoir or groundwater levels and that, if these continue to decline, water supplies may not be adequate to meet normal needs.

Drought Emergency--A situation declared by an official or administrative head because of indications that the safety, security, health, and welfare of an area's citizens are threatened by drought-related water supply shortages.

Drought Susceptibility--The relative possibility that a particular water user, such as a public water supply system, will experience water supply shortages during drought conditions. Susceptibility is expressed as a percentage, which reflects the amount of the user's available water supply that would be used to meet the user's average daily water demand. As the percentage increases, the possibility of water supply shortages during drought conditions increases.

Emergency Phase--This refers to a water supply shortage situation characterized by severe water supply and water quality problems due to serious resource limitations which are well below the level needed to meet economically and socially important needs. Under Norris' drought management plan, water use would be reduced by 60 percent or more to alleviate these shortages.

Essential Water Use--Water used strictly for domestic and personal uses, firefighting purposes, health and medical purposes, industrial processes, agricultural uses, meeting streamflow requirements, and the use of water to satisfy Federal, state, and local public health and safety requirements. Norris' drought management plan prioritizes these uses into "first," "second," and "third" class uses.

"Trigger" Points--A "trigger" point is a predetermined condition at which a specific decision will be made, such as the issuance of a drought alert, or an action taken, such as a call for water users to conserve water. "Trigger" points are usually based on specific factors or conditions, such as deficiencies in rainfall and runoff, a decline in soil moisture, lower groundwater levels, increasing daily water demands, reduced storage, or some other appropriate condition.

" MCL" or Maximum Contaminant Level--This refers to the maximum permissible level of a contaminant in water which is delivered at the free-flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system.

Nonessential Water Use--Water used strictly for lawn and garden watering, car washing, fountains, amusement (water slides), etc.

Palmer Drought Index--This index indicates prolonged abnormal moisture conditions (dryness or wetness). The index usually ranges from about -6 to +6 with negative values for dry spells and positive values for wet spells. This index usually returns to near normal (zero) levels within a few weeks after the onset of a spell of near-normal precipitation. The response is faster if unusually wet weather follows a dry period or unusually dry weather follows a wet period.

Per Capita Water Use--The average amount of water used per person per day.

pH--A Scale of water acidity or alkalinity which ranges from 0 to 14. A pH of less than 7 indicates acid water, a pH of 7 indicates "neutral" water, and a pH above 7 indicates alkaline water. A pH of 5 is 10 times as acidic as a pH of 6, and a pH of 9 is 10 times as alkalinic as a pH of 8.

Precipitation--The fall of water in any form (rain, snow, hail, or sleet) upon the earth's surface.

Public Water Supply--Water withdrawals by public and private water suppliers and delivery to a variety of users that do not supply their own water. These water uses include domestic, commercial, industrial, and public uses.

Public Water Supply System--Any municipal water system, department, water commission, utility district, or investor-owned system that serves at least 15 connections and/or 25 people at least 60 days per year.

Restrictions Phase--This refers to a water supply shortage situation characterized by a continued decline in available water supplies and water quality. Norris' local drought management plan calls for a 30 to 40 percent reduction in water use during this phase.

Safe Water Yield--The amount of water that can be withdrawn from a surface water (lake, reservoir, or stream) or groundwater source on an ongoing, long-term basis with an acceptably small risk of supply shortage. It is generally the 3-day, 20-year low flow for a nonregulated stream, the pump tested yield of a well, the average daily flow in a regulated stream, or the 90-day sustainable yield of a lake or reservoir.

System Capacity--The maximum amount of raw water a system's water treatment plant can effectively process and deliver. Whenever a system's average daily water use reaches 80 percent of the system's design capacity, system managers should consider and begin planning to expand the system's treatment plant capacity.

System Infrastructure--This refers to the basic engineering facilities and equipment, including the organizational structure, which make up the Norris public water supply system and facilitate its day-to-day operation and maintenance. These facilities include the system's water treatment plant, water mains and distribution lines, storage facilities, and the Commission itself.

3-Day, 20-Year Low Flow--This is the lowest average rate of flow for 3 consecutive days to or below which a stream or river's flow can be expected to decline to once in 20 years on the average. The 3-day, 20-year low flow is frequently used in Tennessee to plan for the disposal of liquid wastes into a stream.

Turbidity--A measure of water's "cloudiness" due to the presence of suspended matter.

Water Conservation--Any beneficial reduction in water use or loss. This can be done by reducing the overall demand for water, improving water use efficiency, reusing and recycling existing water, reducing water losses through leak detection and repair, and improving land management practices.

Water Rationing--The restriction of water use in order to ensure fair distribution and maintenance of available water supplies.

Water Shortage--A situation in which a specific water user's or geographic area's available water supply is inadequate to meet existing and future water demands or when "water availability" conditions are such that a temporary reduction in total use is required to protect the water resource from serious harm.

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APPENDIX I

SAMPLE MEMORANDUM AND PRESS RELEASES

Appendix not reproduced for Guide.
Appendix can be found in the Drought
Management Plan for Norris.

APPENDIX II

LEASE AGREEMENT BETWEEN UNITED STATES OF AMERICA BY TENNESSEE VALLEY AUTHORITY AND THE CITY OF NORRIS, TENNESSEE

Appendix not reproduced for Guide.
Appendix can be found in the Drought Management Plan for Norris.

APPENDIX III

PROPOSED ORDINANCE NO. 359

ORDINANCE NO. 359

AN ORDINANCE TO AMEND TITLE 3, WATER AND SEWER, BY ADDING A NEW CHAPTER, CHAPTER 3, CONSERVATION OF WATER.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF NORRIS as follows:

Section 1. That Title 3, Water and Sewer, be amended by adding a new Title 3, Conservation of Water in its entirety as follows:

13-301. DEFINITIONS. For the purposes of 13-301 through 13-308 the following terms, phrases, words and their derivations shall have the meaning given herein. When not inconsistent with the text, words used in the present tense include future words in the plural include the singular and words in the singular include the plural. The word "shall" is always mandatory and not merely directory.

(1) "City" is the City of Norris.

(2) "Person" is any person, firm, partnership, association, corporation, company, or organization of any kind.

(3) "Water" is water from the City Water Supply System.

13-302. Application of Regulations. The provisions of 13-301 through 13-308 inclusive shall apply to all persons using water both in and outside the City, and regardless of whether any person using water shall have a contract for water service with the City.

13-303. State of Emergency. Be it further ordained that the Norris Water Commission is hereby authorized and empowered to declare a state of emergency, at any time hereafter when same may appear to be necessary or advisable for the general welfare and benefit of the municipality, relative to the use or consumption of water furnished by the municipal water system to its users, customers or consumers. When a state of emergency has been declared, the Water Superintendent is hereby authorized, empowered, and directed to immediately restrict prohibit or regulate the use and consumption of all water by all of the City's users, customers and/or consumers in such a manner, to such an extent, and for such a length of time as is necessary or advisable for the general welfare and benefit of the municipality.

13-304. Certain Uses Prohibited. When an emergency is declared, the use and withdrawal of water by any person for the following purposes is hereby prohibited; except by expressed permission granted by the Water Superintendent.

(1) Watering yards. The sprinkling, watering or irrigating shrubbery, trees, lawns, grass, ground covers, plants, vines, gardens, vegetables, flowers, or any other vegetation.

(2) Washing mobile equipment. The washing of automobiles, trucks, trailers, trailer houses, or any other type of mobile equipment.

(3) Cleaning outdoor surfaces. The washing of sidewalks, driveways, filling station aprons, porches and other outdoor surfaces.

(4) Cleaning buildings. The washing of the outside of dwellings; the washing of the inside and outside of office buildings.

(5) Cleaning equipment and machinery. The washing and cleaning of any business or industrial equipment and machinery.

(6) Ornamental fountains. The operation of any ornamental fountain or other structure making a similar use of water, not employing a recirculating system.

(7) Swimming pools. Private swimming and wading pools.

(8) Escape through defective plumbing. The escape of water through defective plumbing, which shall mean the knowing permission for defective plumbing to remain out of repair and which will include defects in swimming pools and fountains.

(9) Air conditioning. Use of air conditioning equipment requiring water, not employing a recirculating system.

(10) Restaurant service. Drinking water will not be served with meals unless specifically requested by the customer.

13-305. Enforcement. Every police officer of the City shall in connection with his duties imposed by law, diligently enforce the provisions of this Ordinance. The Water Superintendent shall have the authority to enforce the provisions of this Ordinance by the discontinuance of water service in the event of violation hereof in addition to the penalties set out herein below.

13-306. Penalties. Any person who shall violate the provisions of 13-301 through 13-308 inclusive shall be fined no less than ten dollars ($10.00) nor more than fifty dollars ($50.00) for each and every offense.

13-307. Separability. If any section, sub-section, sentence, clause, phrase or portion of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate, distinct and independent provision and such holding shall not effect the validity of the remaining portions hereof.

ORDINANCE NO. 359
PAGE THREE

13-308. Ordinance Repealed. All ordinances or portions thereof in conflict with the provisions of this Ordinance are hereby repealed as of the effective date of this Ordinance.

Section 2. This ordinance shall take effect fifteen (15) days from and after its passage, the public welfare requiring it.

PASSED FIRST READING May 9, 1988

PASSED SECOND READING _____

PASSED THIRD READING _____

_____
Roger W. Bollinger, Mayor

CORRECT: ATTEST

_____
Coleen Sheppard, Acting City Manager